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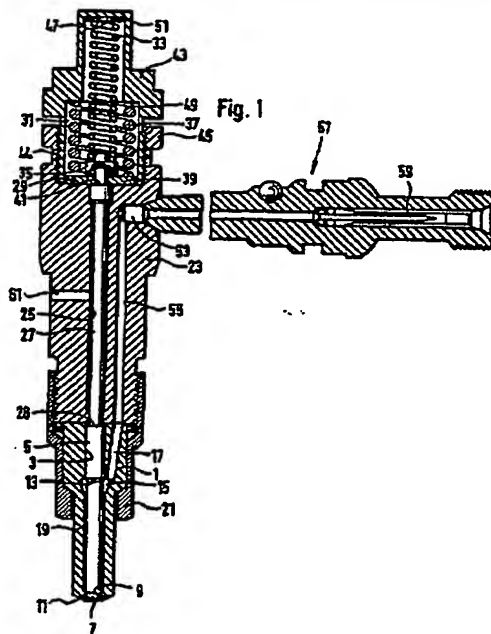
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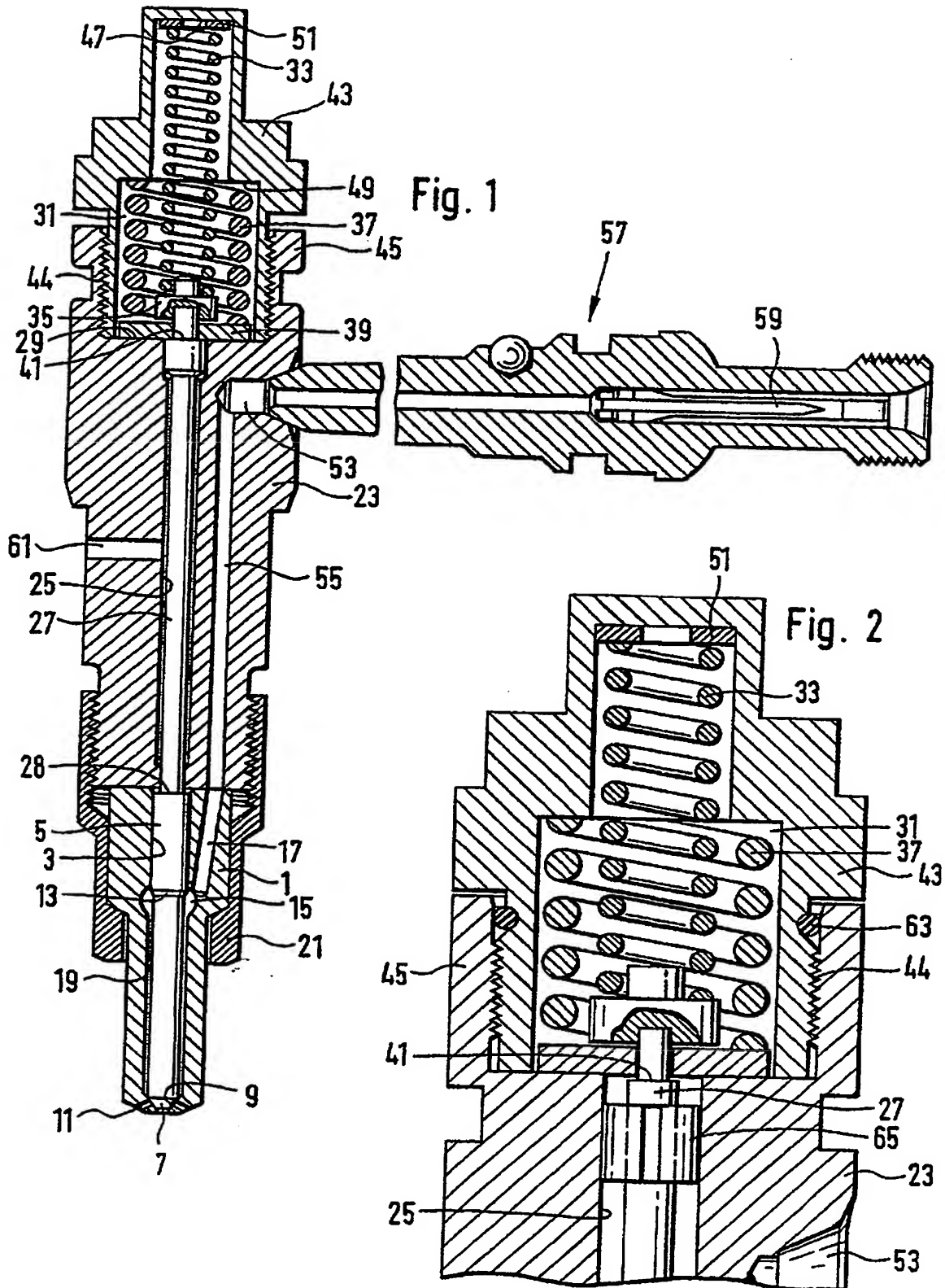
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(54) IC engine fuel injection valve

(57) A valve element 5 is guided in a valve body 1 which is clamped against a valve-retaining body 23 having a spring chamber 31 formed adjacent its end face 29 for receiving two coaxial valve springs for loading the valve element 5 in its closing direction. The first valve spring 33 acts permanently on the valve element 5 and the second valve spring 37 acts on the valve element only after completion of a preliminary travel of the valve element 5 in the opening direction. Adjusting devices, e.g. discs 39, 51 of selectable thickness or screw-threaded members (67, 73, Fig 3), accessible without dismantling structural parts carrying high-pressure fuel, are provided for adjusting the preloading force of the valve springs (33, 37). A lateral high-pressure fuel connection 53 is disposed between the spring chamber 31 and the valve body 1.



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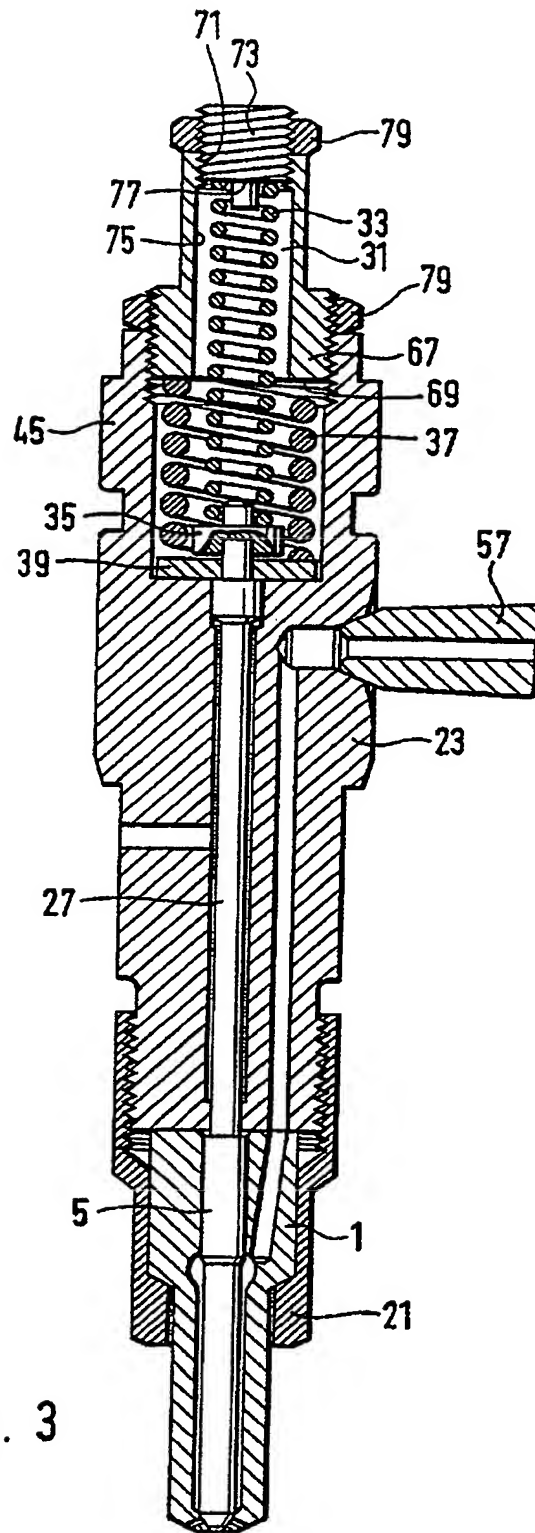


Fig. 3

Fuel injection valve for internal combustion engines**Background art**

The invention proceeds from a fuel injection valve for internal combustion engines according to the preamble of claim 1. In such a fuel injection valve for i.c. engines known from CH-PS 350835, a piston-shaped valve element is guided in an axially displaceable manner in a valve body which is firmly clamped with its end face remote from the combustion chamber axially against a valve-retaining body. Formed at the end face of the valve-retaining body remote from the valve body is a so-called upper-lying spring chamber, into which are inserted two valve springs arranged coaxially relative to one another. Said valve springs via a plunger rod, which axially penetrates the valve-retaining body, load the valve element in closing direction, a first valve spring acting permanently upon the valve element while a second valve spring acts upon the valve element only after completion of a specific opening travel of the valve element. By virtue of the upper-lying spring chamber it is then possible to provide on the valve-retaining body a lateral fuel connection which is disposed between the spring chamber and the valve body, thus offering the advantage of a short high-pressure line to the injection valve, which line may moreover extend in a region of greater wall thickness in the valve-retaining body, thereby increasing the high-pressure resistance of the valve. Furthermore, in said manner the installation space made available for receiving the valve springs is not impaired by an additional pressure line or by the installation conditions at the engine, with the result that a relatively free choice of spring is possible.

The known fuel injection valve does however have the drawback of not providing an adjusting facility for the preloading force of the valve springs even though such

a facility is essential for adjusting the opening pressures of the invention valve. Fuel injection valves having such adjusting facilities are admittedly already known from background art but they are without exception injection valves having a lower-lying spring chamber and in which the high-pressure connection is situated at the end of the spring chamber remote from the valve body. Said injection valves however have the drawback that to adjust the opening pressures and/or preloading force of the springs the entire injection valve has to be dismantled, with the result that subsequent assembly errors or fouling of the structural parts carrying high-pressure fuel may arise.

#### Advantages of the invention

In contrast, the fuel injection valve for i.c. engines according to the invention having the characterizing features of claim 1 has the advantage that an adjustment of the opening pressures of the valve or of the preloading force of the valve springs is possible from above without the structural parts carrying high-pressure fuel having to be dismantled for said purpose.

Said adjustment may be effected advantageously by means of adjusting discs of differing thickness which are axially clamped in between a stationary seating face and the valve springs. The spring chamber is formed by a cap, which comprises a separate structural part and is screwed in a simple manner into a flange at the end of the valve-retaining body remote from the valve body. Said cap of a structurally simple design then forms, with its closed end face, a first step - or seating face for a first radially inner-lying valve spring and, with an annular shoulder formed by a variation in diameter, a second seating face for a radially outer-lying valve spring. Said cap may be made of a simple and inexpensive material since it is not required to apply high sealing pressures.

The facility, illustrated in the second embodiment, for adjusting the preloading force of the valve springs from above has the advantage of being operable fully from the outside so that there is no need at all for structural parts to be dismantled in order to adjust the opening pressures. To said end, the spring chamber at its end remote from the valve-retaining body is now delimited by an inserted hollow screw, which has an annular end face projecting into the spring chamber and forming the seating face for the radially outer valve spring. Screwed into a central through-hole of the hollow screw is a further adjusting screw, which with its end face projecting into the spring chamber forms a further seating face for the radially inner-lying valve spring. It is therefore possible in a simple manner to use the depth of engagement of the two adjusting screws to effect an external adjustment of the preloading force of the valve springs and hence of the opening pressure of the injection valve.

Locking of the adjusted position of the adjusting screws is effected by means of lock nuts. Removal of overflow oil is furthermore effected via an overflow oil bore leading from the pilot bore in the valve-retaining body, a specific overflow oil pressure however being maintained in the system in order to ensure a supply of overflow oil into the spring chamber for lubrication of the valve springs. Alternatively, the overflow oil may be removed directly from the spring chamber via corresponding connections. Given use of the cap, sealing of the overflow oil is effected by means of a sealing ring clamped in between the cap and the wall of the flange.

A further advantage of the illustrated valve construction is achieved by mounting a slotted sleeve onto the plunger rod guided in the pilot bore, which sleeve slides with its outer periphery along the bore wall and is made of bronze or brass, thereby further minimizing the frictional wear.

Furthermore, in order to increase the high-pressure resistance of the valve-retaining body, in particular to injection pressures of up to 2000 bar, the lateral intake bore of the high-pressure connection may be extended past the axial pilot bore and the axial intake bore may be disposed behind the pilot bore, thereby achieving a uniform distribution of stresses over the valve-retaining body.

Further advantages and advantageous refinements of the subject matter of the invention are indicated in the description, the drawings and the claims.

### Drawings

Two embodiments of the fuel injection valve for i.c. engines according to the invention are illustrated in the drawings and explained in detail in the following description.

Of the drawings, Figure 1 shows in longitudinal section a first embodiment of the fuel injection valve in which the valve springs are disposed in a mounted cap, Figure 2 a modified construction of the first embodiment in an enlarged detail from Figure 1 and Figure 3 a view as in Figure 1 of a second embodiment in which the spring chamber is delimited by two adjusting screws which act upon the valve springs.

### Description of the embodiments

In the first embodiment of the fuel injection valve according to the invention illustrated in Figure 1, a valve body 1, the free end of which projects into the combustion chamber of the i.c. engine, has a valve element bore 3 in the form of a blind hole, in which a piston-shaped valve element 5 is guided in an axially

displaceable manner.

The valve element 5 at its bottom end face directed towards the combustion chamber has a conical valve sealing surface 7, by means of which the valve element for the purpose of controlling an injection cross section cooperates with a conical valve seating face 9, which is disposed at the closed end of the valve element bore 3 and from which two injection openings 11 lead into the combustion chamber of the i.c. engine. The valve element 5 further has a pressure shoulder 13 directed towards the valve seat 9 and projecting into a pressure chamber 15, which is formed by a cross-sectional enlargement of the bore 3 and into which moreover a pressure channel 17 opens and which is connected by an annular gap 19 to the valve seat 9.

The valve body 1 at its end remote from the combustion chamber is firmly clamped by means of a clamping nut 21 axially against a valve-retaining body 23, which has a central pilot bore 25 extending in axial extension to the valve element bore 3 in the valve body 1. Guided in said pilot bore 25 is a plunger rod 27 which is applied against the end face 28 of the valve element 5 remote from the combustion chamber.

Adjoining the upper end face 29 of the valve-retaining body 23 remote from the valve body 1 is a spring chamber 31, in which are disposed two valve springs arranged coaxially relative to one another and loading the valve element 5 in closing direction towards the valve seat 9. A first radially inner-lying valve spring 33 acts permanently upon the valve element 5 via a spring cup 35 lying adjacent to the end of the plunger rod 27 remote from the valve element, while a second radially outer-lying valve spring 37 makes contact via a disc-shaped thrust piece 39, which surrounds the plunger rod 27 and lies adjacent to the end face 29, with an annular step 41 of the plunger rod 27 only after completion of a specific

opening travel of the valve element 5. The stationary counterstop faces of the valve springs 33, 37 are formed by a cap 43, which delimits the spring chamber 31 and is screwed by means of a thread 44 on the outer periphery of its open end into a flange 45 projecting axially from the end face 29 of the valve-retaining body 23. The closed end face of the cap 43 then forms a first stationary step 47 or a first stop face, against which the first radially inner-lying valve spring 33 is supported. The cap increases in diameter towards the valve-retaining body 23 so as to form an annular step 49, which forms a second stop face against which the second radially outer valve spring 37 is supported. The preloading force of the valve springs 33, 37 may then be adjusted by providing adjusting discs of differing thickness between the springs 33, 37 and the stop faces 47, 49 or the spring cup 35 and thrust piece 39 respectively.

In the embodiment, adjustment of the preloading force of the inner-lying valve spring 33 is effected by means of an adjusting disc 51 clamped in between the spring 33 and the step 47 and of the outer-lying valve spring 37 by means of the dimensions of the thrust piece 39 which in said case also serves as an adjusting disc, thereby making it possible to dispense with an additional disc clamped in between the valve spring 37 and the annular step 49.

The high-pressure fuel supply to the injection valve is effected via a lateral high-pressure connection 53, which is disposed between the spring chamber 31 and the valve body 1 and connected by means of an axial pressure line 55 to the pressure channel 17 leading to the pressure chamber 15. Braced in a known manner against said lateral high-pressure connection 53 is a pressure pipe socket 57 in the housing of the i.c. engine, which socket comprises a fuel filter 59 and is connected by its free end to a fuel injection line (not shown) leading from an injection pump.

Removal of the overflow oil at the valve element 5 is effected via an overflow oil

bore 61, which leads from the pilot bore 25 in the valve-retaining body 23 and is connected to the lubricating oil circuit of the i.c. engine, the pressure conditions in the overflow oil flow being so designed that some of the overflow oil passes into the spring chamber 31 and lubricates the valve springs 33, 37 there.

In the slightly modified embodiment shown in Figure 2, a sealing ring 63, preferably an O-ring, is clamped in between the cap 43 and the flange 45 and seals off the injection valve from the outside. A slotted sleeve 65 is moreover provided at the level of the annular step 41 on the plunger rod 27, which sleeve slides with its outer periphery along the wall of the pilot bore 25 and is made of a wear-resistant material, e.g. brass or bronze. The transfer at the slotted sleeve 65 of overflow oil into the spring chamber 31 is guaranteed by the longitudinal slot in the sleeve 65.

The second embodiment of the fuel injection valve according to the invention illustrated in Figure 3 differs from the first embodiment in the manner of adjustment of the valve springs 33, 37 and of construction of the spring chamber 31 while being otherwise identical in construction and function to the first embodiment shown in Figure 1.

Here, the spring chamber 31 is provided directly in the axially extended flange piece 45 of the valve-retaining body 23, into the open end of which is first screwed a first externally adjustable adjusting screw 67, which takes the form of a hollow screw and with its annular end face 69 projecting into the spring chamber 31 forms a seating face for the radially outer-lying valve spring 37. The adjusting screw 67 at its end projecting out of the spring chamber 31 has a threaded opening 71, into which a second externally operable adjusting screw 73 is screwed. Said second adjusting screw 73 with its end face 77 projecting into the inside diameter 75 of the first adjusting screw 67 forms a seating face for the radially inner-lying

valve spring 33, a pin projecting from the end face 77 for improved guidance of the spring 33.

The lateral surfaces of the adjusting screws 67, 73 have contours for the engagement of a screw tool as well as external threads for applying lock nuts 79, by means of which the screws are fixable in position.

The fuel injection valve according to the invention operates in the following manner.

In the closed state, the valve element 5 is held by the valve spring 33, which acts permanently upon it, in contact with the valve seat 9 so that the passage to the injection opening 11 is closed.

When an injection is to be effected, fuel under high pressure is supplied through the pipe socket 57 to the injection valve, the fuel flowing through the lateral high-pressure connection 53, the pressure line 55 and the pressure channel 17 into the pressure chamber 15, where it continues via the annular gap 19 as far as the valve seat 9. When a specific injection pressure has been reached, the pressure acting in opening direction upon the shoulder 13 of the valve element 5 exceeds the restoring force of the valve spring 33 and the valve element 5 is lifted off the valve seat 9, thereby releasing between valve sealing surface 7 and valve seating face 9 an opening cross section through which the fuel passes into the injection openings 11 and on into the combustion chamber of the i.c. engine to be supplied. The valve element 5 and the plunger rod 27 move up further in opening direction until the annular step 41 of the plunger rod 27 comes into contact with the thrust piece 39, with the result that the second valve spring 37 then also comes into effect. The sudden increase in the restoring force then causes an interruption in the opening travel of the valve element 5, which remains in its position (end of preliminary

travel). With the further increase of the fuel pressure in the pressure chamber 15, the force of the second valve spring 37 is then also surmounted and the valve element 5 continues its opening travel up to contact of its end face 28 remote from the combustion chamber with the end face of the valve-retaining body 23, by means of which the total travel and the maximum opening cross section are determined.

Upon completion of the high-pressure supply, the pressure in the pressure chamber 15 drops back down below the injection pressure and the valve element 5 is moved by the valve springs 33, 37 back against the valve seat 9.

In said valve, it is possible to use the preloading force of the radially inner-lying valve spring 33 acting permanently upon the valve element 5 to adjust the injection opening pressure of the preliminary travel phase and to use the outer valve spring 37 to adjust the opening pressure of the second travel phase of the valve element 5.

In the case of the injection valve according to the invention, said adjustment is possible in a simple manner from above, for which purpose in the first embodiment (Figs. 1, 2) the appropriate adjusting discs 51, 39 are easily exchangeable by unscrewing the cap 43.

In the second embodiment (Fig. 3), adjustment of the preloading force of the valve springs 33, 37 may be effected externally in a simple manner by means of the depth of engagement of the adjusting screws 67, 43, the adjusted positions of the adjusting screws then being locked against independent rotation by means of lock nuts 79.

**CLAIMS**

1. Fuel injection valve for internal combustion engines, having a piston-shaped valve element (5) guided in an axially displaceable manner in a valve body (1) which is firmly clamped axially against a valve-retaining body (23), and having a spring chamber (31) formed at the end face (29) of the valve-retaining body (23) remote from the valve body (1) for receiving two valve springs, which are arranged coaxially relative to one another and load the valve element (5) in closing direction, of which a first valve spring (33) acts permanently upon the valve element (5) and a second valve spring (37) acts upon said valve element only after completion of a preliminary travel of the valve element (5) in opening direction, as well as having in the valve-retaining body (23) a lateral high-pressure fuel connection (53) disposed between the spring chamber (31) and the valve body (1), characterized in that the spring chamber (31) is formed by a further structural part, which is braced axially against the valve-retaining body (1) and on which are provided a first stop face for the first valve spring (33) and a separate second stop face for the second valve spring (37), there being associated with the stop faces means of adjusting the preloading force of the valve springs (33, 37).

2. Fuel injection valve according to claim 1, characterized in that the spring chamber (31) is formed in a cap (43), which is braced against the end face (29) of the valve-retaining body (23) remote from the valve body (1) and at the closed end face of which remote from the valve-retaining body (23) a first stop face (47) and at an annular face formed by a reduction in diameter of the cap (43) a second stop face (49) are formed for seating of the valve springs (33, 37).

3. Fuel injection valve according to claim 2, characterized in that the adjusting means of the valve springs (33, 37) take the form of adjusting discs which are in each case clamped axially between a stationary step, preferably the stop faces (47, 49), and a valve spring (33, 37).

4. Fuel injection valve according to claim 2, characterized in that the cap (43) is screwed by means of an external thread (44) provided on its open end into a corresponding internal thread of a flange (45) projecting axially from the end face (29) of the valve-retaining body (23).
5. Fuel injection valve according to claim 4, characterized in that a sealing ring (63) is clamped in between the wall of the cap (43) and the wall of the flange (45).
6. Fuel injection valve according to claim 1, characterized in that the adjusting means of the valve springs (33, 37) are formed by externally accessible adjusting screws which may be screwed into the valve-retaining body (23), project into the spring chamber (31) and by means of which in each case one stop face of one of the valve springs is adjustable.
7. Fuel injection valve according to claim 6, characterized in that a first adjusting screw (67) is formed by a hollow screw which is screwed axially into the open end of the spring chamber (31) remote from the valve-retaining body (23), has an annular end face (69) projecting into the spring chamber (31) and forming a stop face for a radially outer-lying valve spring (37) and has screwed into its inside diameter (71, 75) delimiting the spring chamber (31) a second adjusting screw (73), which with its end face (77) projecting into the hollow screw forms a further stop face for a radially inner-lying valve spring (33).
8. Fuel injection valve according to claim 7, characterized in that the adjusting screws (73, 67) forming an adjustable stop for the valve springs (33, 37) are fixable in their position by means of lock nuts (79).
9. A fuel injection valve substantially as herein described with

reference to Figure 1, Figure 2 or Figure 3 of the accompanying drawings.



Application No: GB 9704128.9  
Claims searched: 1 - 9

Examiner: C J Duff  
Date of search: 21 May 1997

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:  
UK CI (Ed.O): F1B  
Int CI (Ed.6): F02M 61/00, 61/16, 61/20  
Other: On-line: WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
Y	GB 2240587 A (LUCAS) Figs 1, 2	6
Y	GB 1363614 (ALLIS-CHALMERS) Whole document	1, 6
X,Y	CH 350835 (FRIEDMANN & MAIER) Fig 1	X:1 Y:1, 6

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.